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Graduating Wedges. By Captain W. de W. Abney, C.B., R.E., D.C.L., F.R.S.

In some cases where wedges are very opaque it becomes difficult to arrive visually at the correct graduation, as light from an ordinary source, such as a lamp, will not pass through with sufficient quantity to enable an accurate measure to be made. The light which it seems most desirable to employ is the electric (arc) light, since it is far more luminous than a lamp or candle, and it has the advantage that a large quantity of light is emitted from what is practically a point. There are, however, variations in the electric (arc) light from time to time, and unless the comparison light, with which the relative intensities passing through different parts of the wedge are measured, varies at exactly the same time and in the same proportion, the measurements will often be very much out. If we merely wish to measure the white light transmitted, the apparatus to employ is not very extensive, and fig. 1 will show what it is. EL is the electric light placed in a lantern or box of some kind, to prevent the room, which should be slightly darkened, from being flooded with bright white light. L_1 is a condenser which throws an image of the crater of the positive pole upon the slit S of the collimator C. The rays issue parallel and are caught by a lens L_{III}, which forms an image of the slit upon the surface of the wedge W, placed in a proper position and in its mountings. The light after passing through the wedge forms a circle of light on the screen. It will be noticed that the image of the slit may be as narrow as one wishes by opening or closing S, and that we have a line of light passing through the wedge, such as is required to effect the graduation. Calculation will show that with a fairly narrow slit the measured intensity passing through it may be taken as that passing through the mean thickness of that part on which the image falls.

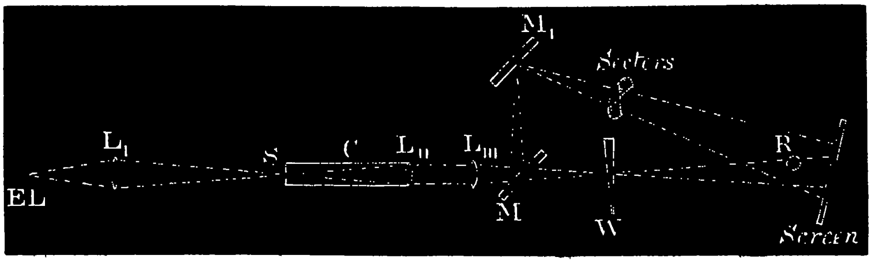

Fig. 1.

Placed in the path of the beam, and between the wedge and L_{III}, is a plain mirror M (for which I often substitute a prism of $1\frac{1}{2}°$, and so obtain a single reflection), which reflects the light at right angles, or any convenient angle to its path. It is again reflected from M_1, a silver on glass mirror. An image of the slit is formed in the path and a second disc is formed on the screen. The centre of this disc is made to coincide with the centre of the disc formed by the light passing through the wedge. A rod R is placed in the path of the two beams, which casts two shadows, one illuminated by one beam and one by the other. The usual black mask is used on the screen, to confine the attention to a small part of the shadows.

It will be seen that when any variation takes place in the light it equally affects both the illuminated shadows; hence the measures may be made without fear of error creeping in. Sectors with apertures, movable at will whilst they are rotating, are introduced, as shown in the figure, and sometimes a second set of fixed sectors are introduced between M and W should the light passing through W be too bright. The screen is placed perpendicular to the line bisecting the angle made by the two beams. It should be noted that this plan almost necessitates movable sectors, but sectors which are fixed at known apertures can be used at a pinch, and the balance made by moving the wedge in its settings.

It should be remarked that though the wedge may not be pure black the readings can be very readily made by the method of oscillating between "too light" and "too dark" for the shadow whose brightness is controlled by the sector. In making a valuation of the wedge, the first thing to do is to compare the lights without the intervention of the wedge, and then to take readings.

Fig. 2.

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For certain purposes it is necessary to know how much of each colour of the spectrum is transmitted through a wedge, and fig. 2 shows how this is accomplished.

The electric light and the collimator are placed as before, but the parallel emergent rays fall upon a pair of prisms, and the spectrum is brought to a focus by $L_{\rm II}$ on to a screen in which there is a slit against which the wedge in its setting is placed. The slit can be placed in any spectrum ray, and the wedge surface is always kept perpendicular to that ray. A lens $L_{\rm III}$ brings the rays to a focus, so that a monochromatic image of the surface of the last prism is formed on the screen. From the surface of the first prism parallel rays are reflected: these are caught by a mirror and fall on a pair of precisely similar prisms, and the remainder of the apparatus is exactly the same as that described above, a second patch of coloured light being formed over the first patch. The slit $S_{\rm III}$ is so adjusted in the spectrum that the two patches are of the same colour. The sectors are placed as shown in the figure, the rod R forming two shadows, as before. The method of procedure is to place the slit $S_{\rm II}$ in some colour in the spectrum, and $S_{\rm III}$ in the same. The wedge is then graduated for this beam throughout its length, another position is taken up and the same process gone through. By this means we get the logarithmic factor of transparency for each part of the wedge for the whole of the spectrum colours. As I have mentioned in another paper, the factor most essential to know for extinction purposes is that for the part of the spectrum near the Fraunhofer line E.

Photograph of the Cluster M. 46, *and of the Nebula* H IV. 39 *Argûs.*

By Isaac Roberts, D.Sc., F.R.S.

The photograph of the cluster M. 46 and of the nebula H IV. 39 *Argûs*, R.A. 7$^{\rm h}$ 37$^{\rm m}$, Decl. 14° 30′ south, was taken with the 20-inch reflector on 1894 February 24, with exposure of the plate during 90 minutes, and the copy now presented is enlarged to the scale of 1 millimetre to 24 seconds of arc.

The cluster is No. 2437 in the *New General Catalogue*, and 1564 in the *General Catalogue*. The nebula is No. 2438 in the *New General Catalogue*, and 1565 in the *General Catalogue.*

Sir J. Herschel describes the cluster as a remarkable object, very bright, very rich, very large, with a planetary nebula involved, which he describes as pretty bright, pretty small, extremely little extended, barely resolvable.

Lord Rosse (*Phil. Trans.*, 1850, p. 513, Pl. XXXVIII., fig. 12, and *Observations of Nebulæ and Clusters of Stars*, p. 61) records twenty-one observations of the nebula made between the years 1848 and 1876. He saw it first as a planetary nebula 60″ in diameter, and subsequently as an annular nebula with two stars, and a suspected third star, in it. Much uncertainty as to the character of the object is shown by the records, and in